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| **Lesson Title: Kites, Surface Area and Newton’s 3rd Law** |
| **Subject area / course / grade level: Science (4-8 grade)** |
| **Introduction:**  **Lift and Newton’s 3rd Law:** Wind striking a kite surface will create a force that causes the kite to fly. This force can be felt as wind pushes on the kite and as the kite tugs on its string. An understanding of Newton’s Third Law explains this force.  Newton’s Third Law, often stated as, “for every action (or force) there is always an equal and opposite reaction (or force),” is one of the basic principles on which flight is based. The law predicts that forces always come in pairs and act in opposite directions. The wind pushing on the kite is equal to the kite pushing back on the wind.  At any time there are four forces acting on a flying kite: lift, weight, thrust, and drag. The force that lifts, or pushes, or pulls the kite vertically upward is called “lift”. Gravity pulls the kite toward the earth. The downward force of gravity acting on the mass of the kite is called “weight”. As you pull on a kite string you are providing “thrust”. The resistance of the kite to the horizontal thrust is called “drag”. When a kite flies as a constant velocity all forces are equal. Lift opposes and equals weight while thrust opposes and equals drag. |
| **Lesson Length: 3-5 hours** |
| **Materials: (for each team of 3/4 students)**   * **2 kites of various sizes or have students build their own kites with standard size grocery bags (instructions attached)** * **Kite string** * **2 pull force meters that measure from 0-50 or 0-20 Newtons.** * **Pencils** * **Meter sticks or rulers** * **Scissors** * **Colored Markers** |
| **Tennessee Standards:**   * **GLE 0507.Inq.1** Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data. * **GLE 0507.Inq.2** Select and use appropriate tools and simple equipment to conduct an investigation. * **GLE 0507.Inq.3** Organize data into appropriate tables, graphs, drawings, or diagrams. * **GLE 0507.Inq.4** Identify and interpret simple patterns of evidence to communicate the findings of multiple investigations. * **GLE 0507.T/E.1** Describe how tools, technology, and inventions help to answer questions and solve problems. * **GLE 0507.11.1** Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled. * **GLE 0507.12.1** Recognize that the earth attracts objects without directly touching them. * **GLE 0507.12.2** Investigate how the shape of an object influences the way that it falls toward the earth. * **GLE 0607.Inq.1** Design and conduct open-ended scientific investigations. * **GLE 0607.Inq.2** Use appropriate tools and techniques to gather, organize, analyze, and interpret data. * **GLE 0607.Inq.3** Synthesize information to determine cause and effect relationships between evidence and explanations. * **GLE 0607.Inq.4** Recognize possible sources of bias and error, alternative explanations, and questions for further exploration. * **GLE 0607.Inq.5** Communicate scientific understanding using descriptions, explanations, and models. * **GLE 0607.6.1** Analyze information about the major components of the universe.   Math Power Standard:  Grade 5:   * Find the area, volume and surface area of geometric figures including irregular shapes, prisms and polyhedral solids. |
| **Lesson objective(s):**   1. Students will be able to describe, in words, Newton’s Third Law of Motion. 2. Students will be able to hypothesize and explain how forces in opposite directions are related. 3. Students will use data to analyze the relationship between variables 4. Students will transform numerical measurements into graphical representations. 5. Students will demonstrate the ability to calculate the surface area of two dimensional objects. |
| **ENGAGEMENT:**  Provide an opportunity for the students to fly the kites. However, before you engage them in this task, ask them to observe, hypothesize and record what forces, they believe, are acting on the kite to keep it flying. After flying the kites, conduct a group discussion about what they observed. |
| **EXPLORATION:**  Present two kites, of different sizes, and ask the students which kite is easier to fly? What factors contribute to their answers? Prior to flying the kites a second time, have them attach two force meters to one another and pull gently apart. Ask them what they notice when they read the meters? Second, ask them…How could we develop an investigation to test which kite is easier to fly?  In the Q&A period, help guide the students into developing the following experiment:   1. Have the students hypothesize which kite will record more force on the meters and why. 2. Have the students create a small loop on each string and attach a force meter. 3. The students should then fly to large and small kites, standing side by side, in a line that runs perpendicular to the wind. Both kites should also be flying at the same altitude. 4. The students should then measure the force pulling each kite at the same time so that the wind speed will be the same for each kite. The teacher should tell the students when to read the forces for each trial. 5. Students should record their data in the table below.  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Kite** | **Force (Newtons) Exerted** | | | | | **Average Force (N)** | | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | | Small |  |  |  |  |  |  | | Large |  |  |  |  |  |  |  1. Have the students graph averages (Bar Graph) on how the Size of the Kite Affects Pulling Force (Newtons)    1. Was your hypothesis correct?    2. Ask what trends do they see?    3. How is each group’s graph alike or different?    4. What kite characteristics played a role in this experiment? |
| **EXPLANATION:**   1. Write Newton’s Third Law of Motion on the board. 2. Explain all the forces acting on the kite.   Lift  Thrust  Drag  Weight  Kite Pulling Force   1. Ask why it was important that the kites were flown at the same height and that we recorded the force at the same time. 2. If the pulling force was increased for the larger kite, what other force also increased? 3. What kite characteristic played a role in the lift and drag forces to increase? (Guide them toward looking at the surface area being impacted by the wind) |
| **ELABORATION:**   1. Ask the students to finish this hypothesis: If the surface area increases, then…. 2. Have the students calculate the surface area of the kites. (Square version or “Real” Surface Area) 3. Replace Small and Large in their table with surface area (cm2) and graph entire class data on How Surface Area (cm2) of the Kite Affects Force (Newtons). |
| **EVALUATION:**  The evaluation of this lab is based on the quality of their lab write up. In conclusion, students will be required to write out and explain Newton’s 3rd Law of Motion. They will be asked to analyze and explain the relationship, in flying objects, between surface area and force using the data shared in class. Finally, students will be asked, when flying a kite, is the kite or their hand pulling harder? How do they know? |